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WOODEN TELEGRAPH POLES.

By E. T. ROLLS, Assoc. Soc. Tel. Engineers.

The importance of a proper selection of this article for the construction of telegraph lines cannot but be admitted, and yet the subject in practice does not appear to receive the consideration it merits.

The introduction of the "creosoting" process has no doubt been a great step in the right direction, yet even here there is certainly room for improvement. It is a plan that doubtless, under certain conditions, answers almost every purpose, but these conditions are not always fulfilled. A "creosoted" pole is by many accepted as representing *un fait accompli*, in respect of nearly everlasting preservation. This is not necessarily so. The proportion of "creosote" imbibed to the cubic contents of the timber, the description of wood selected, and the quality of the creosote itself, are all points of vital importance to the life of a pole, but are frequently disregarded. Experience has shown that those woods which of themselves are the most lasting are least adapted to the creosoting process, as from the density of their fibre it is impossible at any ordinary pressure to saturate them with the antiseptic. I have had to renew creosoted poles less than ten years old, where well grown spruce had been set; and the remains of these poles clearly showed that their early decay was due to the creosote having been unable to penetrate to a sufficient depth. At the ends the wood remained sound for some distance, for here the creosote had forced its way up through the capillary tubes of the wood, as well as from the surface; but as the longitudinal distance increased, the "creosote" was found only in the less dense sapwood, having failed to enter transversely the older and more solid heartwood; consequently except at the ends, and for a distance of about three inches from the skin, the wood showed no trace of creosote, and was more or less decayed. Evidently, then, where poles are to be creosoted, it is better and generally cheaper to select soft woods: one easily obtained in this country is Scotch pine *(Pinus sylvestris)*, which is admirably adapted to any injecting process. It is of very coarse grain; its annual rings are wide apart, and the intervening tissue soft and capable of great absorption. It does not produce so strong a spar as spruce or larch, but it is strong enough for ordinary purposes; and where extra strain occurs, it is easy to place extra strength, by doubling, staying, or strutting.

The quality, or rather description, of the "creosote" I find to bear most materially on the subsequent condition of a pole. Mostly in its manufacture the distillation appears to have been carried on too gently, resulting certainly in a liquid containing a greater proportionate amount of creosote than it would had the pressure been urged. But this slowly distilled liquid can contain only the most volatile products of the coal tar. The pole impregnated with this soon under the influence of sun heat presents a bleached appearance, the heat volatilises a great proportion of the oil of coal tar, and the wood, though showing no sign of ordinary organic decay, is severely affected by the acid and corrosive action of the preparation it has imbibed. The vegetable tissue is partly destroyed; the wood looks desiccated; moisture and air, two of the active agents of decay, find easy access; and although a coat of coal tar will offer a slight remedy, the result is by no means satisfactory.

Now were the distillation of the "creosote" urged, a small portion of more or less undecomposed coal tar would pass over from retort to receiver, and the "creosote" would then contain some pitchy matter. A pole will require greater pressure to saturate it with this product, but afterwards well repays the trouble. The weathering, as before, drives off a portion of the more volatile parts, but the pitch remains in the interstices of the wood; the pole keeps black, is perfectly waterproof—age appears only to make it the harder, and apparently it will last for an indefinite period.

With plain poles the conditions are of course quite changed: the wood which could be best creosoted would probably be least lasting if unprepared. There are many descriptions of foreign-grown pines and firs which make excellent spars, but as a rule their price precludes their use. Norway spruce fir *(Abies excelsa)* is generally straight and well grown, and makes a nice looking pole, but in point of durability has little to recommend it. Scotch pine is totally unfit when grown south; the looseness of its fibre renders it peculiarly liable to the absorption of moisture and air, and to subsequent decay. Larch fir *(Abies larix)* is well spoken of, and no doubt, if properly selected, it lasts well; but, unfortunately, this species is seriously affected by the climate and soil in which it is grown. Reared in the southern counties of this island, where warmth and moisture are more prevalent than in districts further north, and where the soil is also too stimulating, the larch fir produces timber more or less worthless for telegraph purposes, and poles cut from it will not stand long. I have had to renew Devon larch after seven years. But the tree grown in Scotland or Wales, on rocky or stony districts, at an attitude of about 1500 feet above the sea level, yields poles of most excellent quality, which, if cut in the fall, and of about thirty years' growth, will often last fifteen years or more. It is a wood very subject to warping, and shakes under exposure, and therefore is best preserved by coal tarring or painting—preferably the former—which will to a great extent prevent shakes in which wet would lie to the destruction of the pole. Before tarring, however, the pole should be "charred" at the butt. This process, if well performed, is of a great service, but, unhappily, the prevalent idea appears merely to burn the outside wood; this alone is of little use. The pole should at first be roasted slowly at a considerable distance from the fire, not permitting the wood to burn; the effect will be to evaporate the greater part of the aqueous portion of the sap (and at the base of a tree the sap is always more watery, not having commenced solidification by inhalation and exhalation in the leaves) to solidify and render insoluble its albuminous constituent, and possibly to destroy the thallus of fungi, *Polyporus destructor*, and various species of *Sporatrichum*, also to annul the capabilities of the ligneous cells to admit fresh moisture by capillary action. After the pole has been thus slowly roasted long enough for the heat to thoroughly permeate for some time, it may be brought nearer the fire, and well charred on the surface. We now have what may be termed a quickly "kiln-seasoned" piece of timber surrounded by carbon, which latter asserting its property of arresting organic decay, will, if the process has been carefully followed, preserve the wood from decomposition a far longer time than it would have lasted, without the roasting and *entourage* of the antiseptic carbon.

With regard to square poles for station or town work, exactly the same routine should be observed, except in the case of pitch pine, or other woods containing very large quantities of turpentine; charring is then best omitted, the natural contents of the timber being the better preservatives, besides the danger of exposing such inflammable substances to a fire. The roofing of square poles deserves some attention. The primary object of a roof is to prevent moisture from entering and going down the pores of the wood, but this object is often lost sight of, and ornamentation alone kept in view. The pole itself is sometimes cut to a roof shape, and a moulding nailed round to form eaves, or a roof is made and put on, having its grain in the same direction as that of the pole. Both plans are of course mischievous. In the first the wet finds immediate access; in the second it enters after passing through the roof. But if the roof is cut from a thick pine slab, large enough to project two or three inches on each side of the pole, and a moulding fixed beneath this projection, an equally well looking roof is produced, the grain of which, lying horizontally, will effectually preclude the admission of moisture, and the decay of the head of the pole.

ATTRACTION AND REPULSION.

By Robert Sabine, C.E.

Assuming the existence of a single electricity, and that the earth be electrified, suppose the potentials of three bodies, A, B, and C, to be respectively 100, 120, and 170, of some imaginary unit; if the earth potential were represented by 110, then A and B would attract each other, and A and C would also attract each other; but B and C would repel each other. On the other hand, if the earth potential were 130, then A and B would repel each other, whilst both A and B would both be attracted by C. Therefore it is evident that the potential of the earth determines qualitatively the mutual attractions and repulsions of these bodies, and not the absolute differences of their own electrical potentials. Now, when we speak of the earth potential, in such circumstances, it is self-evident that we mean only the potential of those objects immediately surrounding our electrified bodies. Hence, if we had any convenient means of changing this surrounding potential, we might change apparent repulsion between two bodies into attraction, and *vice versâ*, without altering their electricities in the least. Thus, if the potential of the walls of our room were 110 of our assumed units, then the body A would attract both B and C, whilst B and C would repel each other; and if we were then to alter the room's potential to 130, B and C, as well as A and C, would attract each other, whilst A and B would repel each other. Evidently, therefore, the electric attractions and repulsions of these bodies would be, in some measure, more apparent than real; because those which at first attracted each other, would take to repelling each other, and *vice versâ*, when they were not in the least interfered with, but only the electrical potential of the walls of the room were altered. Let us take the bodies singly into the room,—in the centre of it let us hang up a charged pith-ball; it will obviously be attracted equally by the walls all round and not be deflected from its position of rest. But if we approach it with any body similarly charged with itself—that is, both being electrified more than the walls or less than they are—it will be deflected from its position of rest, and appear to be repelled from it. This *repulsion* may, as advanced by the French Franklinians, however, be only apparent: for the presence of the similarly electrified body intercepting the attraction of the walls on that side, the suspended body must necessarily lose its equilibrium, and the walls on the opposite side, exerting their full force upon it, it will be pulled towards them. It is even probable that, if the two bodies in question be charged to *different* potentials, both being positive, or both negative, they may really tend to attract each other, but that their mutual attraction is overpowered by that of surrounding objects. Reasoning thus, there is perhaps no phenomenon of electrical repulsion with which we are acquainted which may not be reduced to the disturbance of equilibrium between opposite forces of attraction.

In the explanation of observed electrical phenomena, we really do not require to employ the word repulsion at all. The four following statements embody all that is necessary to explain that which appears at first sight to be the effect of repulsion:—

(1). All material on the earth contains electricity.

(2). Bodies charged to the same potential with electricity exert no action whatever upon each other.

(3). Two bodies charged to different potentials attract each other.

(4). Two bodies charged to different potentials when brought together tend to discharge one into the other and to equate their potentials.

The earth's surface being itself highly electrified, we live and move in an electrical state, our bodies covered equally with electricity. We do not observe it, because the potential to which we are raised by contact with the earth being the same as that of the earth, no transfer can take place without special conditions. If any electricity, however, be transferred from one body to another, that which contains more than its natural quantity is charged positively, whilst the other which contains less is charged negatively. If we take electricity from the earth and put it into an insulated conductor, the deficiency is in the earth; it is not, however, distributed over its surface nor throughout its mass, but, whilst the insulated conductor remains stationary, the deficiency remains subtracted from the surface in its immediate neighbourhood. And, when the insulated conductor is moved away, the deficiency follows it like its shadow, coming as near to it as it can, held by what is called influence, or induction, and recombining with it, or retaking its own, when it comes sufficiently near to enable it to do so. On the other hand, if we take electricity from an insulated conductor and put it into the earth, the excess does not distribute itself over the earth's surface, but hovers about as close as it can get to its negative until it reaches it. All this time the bodies which happen, at the moment, to contain this excess and deficiency, being charged to different potentials, tend to approach each other; and if very light and easily movable, they will do so.

If the apparent mutual repulsion between electrified bodies is caused by the interception of the attractions of objects behind them, the law that similarly-charged spheres repel each other with a force nearly inversely proportional to the square of the distance between their centres, would follow as a natural consequence. Because, suppose one of the spheres to be placed at a distance of two feet from the other, so that it intercept the attraction of one square inch of the wall behind it, upon each point of the repelled sphere; then it is evident that, by decreasing the distance between them to one foot, the area of wall intercepted will be increased to four square inches, and the difference of the attractions of the opposite sides be therefore increased four times.

MATHEMATICS
FOR
NON-MATHEMATICIANS.

By WILLIAM PAGET HIGGS, LL.D., D.Sc.

DIVISION I.—THE ALGEBRA OF CONSTANT QUANTITIES.

(Continued from p. 249.)

Common Uses of Common Logarithms.

THERE are, of course, many important applications of logarithms that could not be included here. Some of these applications require a technical knowledge of the science to which they are applied; others again call for a knowledge of the higher mathematics to which we have not yet attained. But perhaps the property of logarithms most interesting to the general reader is that relating to compound interest. On this point no one is so clear as the late Professor De Morgan; and, not to make a vain attempt to embody his meaning in words as concise, it will be better to quote in full what he says. The quotation is from the "Essay on Probabilities,"* (p. 13.)

The principle upon which mathematical abbreviation frequently proceeds is this:—that where the calculation of a few results materially aids the production of a great many more, it is advisable to calculate a multitude of results, to arrange them in convenient tables of reference, and to publish them; so that by means of one person taking a little more trouble than would otherwise fall to his share, all others may be saved labour altogether. Mathematical tables are frequently nothing but the result of labour performed once for all; but it also sometimes happens that the principle on which the labour is performed can be exemplified by a familiar case of it. We shall take that of logarithms as an instance.

Every table of logarithms is an extensive table of compound interest.—Not to embarrass ourselves with fractions, let us take a table of *cent* per *cent* compound interest. We have then the following amounts of £1 in 1, 2, 3, &c., years:—

Years.	Amount. £	Years.	Amount. £
0	1	14	16,384
1	2	15	32,768
2	4	16	65,536
3	8	17	131,072
4	16	18	262,144
5	32	19	524,288
6	64	20	1,048,576
7	128	21	2,097,152
8	256	22	4,194,304
9	512	23	8,388,608
10	1,024	24	16,777,216
11	2,048	25	33,554,432
12	4,096	26	67,108,864
13	8,192	27	134,217,728

The property of this table is, that if we wish to multiply together any two numbers called amounts, we have only to add together the number of years they belong to, and look opposite the sum in the table of years. Thus, 11 and 12 *added* together give 23; 2048 and 4096 *multiplied* together give 8,388,608. The reason is as follows:—If £1 in 11 years yield £2048, and if this £2048 be put out for 12 years more, then, since £1 in 12 years yields £4096, 2048 times as much will yield £2048 × 4096; or the amount in 11+12 years is the product of the amounts in 11 and 12 years. The only reason why the preceding table is not in the common sense of the word a table of logarithms, is, that its construction leaves out most of the numbers. We can deal with 2048 and 4096, but there is nothing between them. The remedy is to construct a table of compound interest, at such an excessively small interest, that a year shall never add so much as a pound throughout. Certain considerations, by which the table may be shortened, but with which we have here nothing to do, make it convenient to suppose such a rate of interest, that £1 shall increase to £10 in not less than 100,000 years, at compound interest. Or we may suppose interest payable 100,000 times a year, and say, let the whole *yearly* interest be 1000 per cent per annum. Taking the first supposition, we have a part of a table of logarithms as follows:—

Amount.	Years.	Amount.	Years.
1000	300,043	5232	371,867
1001	300,087	5233	371,875
1002	300,130	5234	371,883
1003	300,173	5235	371,892
&c.,	&c.,	&c.,	&c.

This is the light in which a common reader may view a table of logarithms. Let 1 increase to 10 at compound interest in 100,000 equal moments, then 1 will become 5234 in 371,883 such moments; and so on. We can thus manage to put down every number, within certain limits, as an amount; and thus, within those limits, we reduce all questions of multiplication and division to addition and subtraction by reference to the tables. We thus perceive a simple principle applied with much labour, but such as is performed once for all. The notion above elucidated was the first on which logarithms were constructed; in time came more easy methods.

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* "An Essay on Probabilities, and on their Application to Life Contingencies and Insurance Offices." By Augustus De Morgan, Professor of Mathematics in University College, London. Longmans and Co.

Professor De Morgan then recurs to another method of abbreviation, and we may, for the method will presently be very useful, continue the quotation. The abbreviation is applied to the multiplication of all the successive numbers from 1 up to some high number.

Let [10], for instance, represent the product of all the numbers, from 1 up to 10, both inclusive, or let [10] stand for—

$$1\times2\times3\times4\times5\times6\times7\times8\times9\times10=3{,}628{,}800.$$

[1] is 1; [2] is 2; [3] is 6; [4] is 24; [5] is 120; [6] is 720; [7] is 5040; [8] 40,320; and so on. This labour becomes absolutely unbearable when the numbers become larger; thus [30] (or the numbers up to 30 multiplied together) contains 33 places of figures, and [1000] contains 2568 figures. But, nevertheless, we cannot deal with problems in which there are 1000 possible cases without knowing, *either nearly or exactly*, the value of [1000]. It will, however, be sufficient to know this value very nearly; within, say, a thousandth part of the whole; that is, as nearly as when, the answer of a problem being 1000, we find something between 999 and 1001. We now put before the reader who can use logarithms a rule for this approximation, with an example; intending thereby to show the reader who does not comprehend the process, how mathematics enter into the abbreviation of tedious computations.

Rule.—To find very nearly the value of [a given number], from the logarithm of that number, subtract 0·4342945,* and multiply the difference by the given number, for a first step. Again, to the logarithm of the given number, add 0·7981799, and take half the sum, for a second step. Add together the results of the first and second steps, and the sum is nearly the logarithm of the product of all numbers up to the given number inclusive. For still greater exactness, add to the final result its aliquot part, whose divisor is 12 times the given number.

Example.—What is—

$$[30] \text{ or } 1\times2\times3\times\ldots\ldots\times29\times30?$$

First step.

$$\begin{array}{rr} \text{log. } 30= & 1{\cdot}4771213 \\ & 0{\cdot}4342945 \\ \hline & 1{\cdot}0428268 \\ & 30 \\ \hline & 31{\cdot}284804 \text{ Result.} \end{array}$$

Second step.

$$\begin{array}{rr} \text{log. } 30= & 1{\cdot}4771213 \\ & 0{\cdot}7981799 \\ \hline & 2)2{\cdot}2753012 \\ \hline & 1{\cdot}1376506 \text{ Result.} \end{array}$$

The sum of the results is—

32·422455

which is the log. of result of problem.

The result has, therefore, 33 places of figures, of which the first six are (nearly) 264,518; or, if this be increased by its 360th (12 times 30) part, or about 735, the result is 265,253, followed by 27 ciphers, and the error is not so much of the whole as one part out of 500,000. In this way, we are able to do with more than sufficient nearness, and in a few minutes, what it would take days to arrive at by the common method and with much greater risk of error.

If we wish to find the product of all the numbers, say, from 31 to 100, both inclusive, we find [100] and [30] approximately, and divide the first by the second.

This selection from a work that should be better known to the reader of mathematical tendency will serve to illustrate the application of logarithms to extremely lengthy calculations. Another application now to be considered is to the immediate computation of amounts at compound interest, a class of calculation in which logarithms are of high value.

Before the subject can come within easy grasp, there will be necessary some explanation of other terms than those already made known. An amount at compound interest increases in what is named geometrical progression.

Arithmetical and Geometrical Progression.

An amount (a) is ordinarily understood to be capable of increase by one of two methods:—

(1). It may increase by a constant difference, d, as—

$$a,\ a+d,\ a+d+d,\ a+d+d+d,\ \&c.,$$

or—

$$a,\ a+d,\ a+2d,\ a+3d,\ \&c.,$$

when the progression is said to be *arithmetical.* For example—

$$1,\ 2,\ 3,\ \&c.,$$

is an arithmetical progression, the difference, d, being 1. This progression might be written:—

$$1,\ 1+1,\ 1+1+1,\ \&c.$$

It will be seen that the last term (l) can be obtained from the formula—

$$l=a+(n-1)d,$$

where n is the number of terms, a the first term, and d the common difference. Thus—to give a self-evident example—the last term of the arithmetical series,

$$1,\ 2,\ 3,\ 4,\ 5$$

is—

$$1+(5-1)1=5.$$

(2). Or an amount may increase by multiplication by a constant quantity. An amount is then said to increase in *geometrical* progression, as—

$$2,\ 4,\ 8,\ 16,\ 32,\ \&c.$$

While, in any *arithmetical* series or progression, a number or term subtracted from the next following number or term, yields a constant *difference;* in a *geometrical* series, a term divided into the next term gives a constant *quotient* or *ratio.* The common ratio of the series just given is 2. The general algebraic formula for the geometrical series is—

$$a,\ a\,r,\ (a\,r)r,\ (a\,r\,r)r,\ \&c.,$$

or—

$$a,\ a\,r,\ a\,r^2,\ a\,r^3,\ \&c.,$$

a being the first term, and r the common ratio or constant multiplier. Study of the series will show us that the last term (l) will be equal to

$$l=a\,r^{n-1}.$$

The last term in the given series is thus—

$$l=2(2^{5-1})=2(2^4)=2\times16=32.$$

An amount increasing at compound interest or in geometrical progression, is thus put before us in a new light. For, if it be required to know—what will be the amount of a given sum placed at compound interest for so many years, at such a rate per cent—we can put the question under the form —what is the last term (the amount) of a geometrical series, to be obtained from a knowledge of the first term (the sum placed out), the number of terms (years), and the common ratio (rate per cent).

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* These numbers are obtained by calculation, which need not be given here.

Example.—Required the amount, at compound interest, of £2273, in 3 years, at 5 per cent?

Here 2273 is the first term; 3 the number of terms; and 1·05 (the amount of £1 for 1 year) the common ratio. Now, the formula $l = a\,r^n$ directs us to raise r, the common ratio to the n^{th} power, and to multiply the result by the first term. The log. of $r = 1{\cdot}05$ is 0·0211893, and this multiplied by n or 3 (see Rule III. for logarithms) is =0·0635679.

$$\begin{array}{lr} \text{log. } (1{\cdot}05 \times 3) = & 0{\cdot}0635679 \\ \text{log. } 2273 = & 3{\cdot}3565994 \\ \hline & 3{\cdot}4201673 = \text{log. } 2631{\cdot}2. \end{array}$$

Answer £2631 10s.

Had we from the amount £2631 10s. sought the principal, the interest being given, the following process—the reverse of the preceding—would have been adopted:—

$$2631{\cdot}2 \div 1{\cdot}05^3 = \text{principal, or—}$$

$$\frac{l}{r^n} = a.$$

$$\begin{array}{lr} \text{log. } 2631{\cdot}2 = & 34201673 \\ \text{log. } 1{\cdot}05^3 = & 0{\cdot}0635679 \\ \hline & 3{\cdot}3565994 = \text{log. } 2273. \end{array}$$

Had the rate of interest been demanded, the method employed would obviously have been that indicated by the expression—

$$1{\cdot}05^3 = 2631{\cdot}2 \div 2273, \text{ since}$$

$$2273 \times 1{\cdot}05^3 = 2631{\cdot}2; \text{ or } r^n = \frac{l}{a}.$$

$$\begin{array}{lr} \text{log. } 2631{\cdot}2 = & 3{\cdot}4201673 \\ \text{log. } 2273 = & 3{\cdot}3565994 \\ \hline & 3\,)\,0{\cdot}0635679 \\ \hline & 0{\cdot}0211893 = \text{log. } 1{\cdot}05. \end{array}$$

1·05 is an increment to 1 of 0·05, or 5 in the hundred (per centum).

Had the time been required, we find—

$\text{log. } 1{\cdot}05^3 \div \text{log. } 1{\cdot}05 = 3$, the number of years; or—

$$\frac{r^n}{r} = n.$$

A very neat application of the laws of compound interest to electrical science will be found in the appendix to Mr. Culley's "Handbook of the Telegraph," in the determination of the state of insulation of a cable by fall of charge.

What to do in a Thunderstorm.—A person reclining on a sofa or bed, at a distance from all the walls of the room, could scarcely suffer injury, even in a house struck by lightning; but most absolute security is obtained by lying on an iron or brass bedstead, of the form known as the Arabian bedstead, in which the head is surmounted by an iron erection supporting the curtains. A person lying or sleeping on such a bedstead could not possibly receive any direct injury, even if the house were demolished, and his bedstead forms the most complete lightning protector which could well be devised. A wooden bedstead placed against the wall does not afford any special security.—*Latimer Clark.*

ON THE

ENERGY OF ELECTRICITY, WITH ESPECIAL REFERENCE TO THE MEASUREMENT AND UTILISATION OF IT.*

By the Rev. ARTHUR RIGG, M.A.

The energy of electricity is being manifested in phases new to men day by day. That which in the early part of the present century was unknown, is now so well known as to win neither surprise nor notice. The telegraph which girdles the earth—the electro-deposition of metals—the light which pales our brightest—the power which melts the most refractory metals—these have been handed down by science to promote the commercial and social welfare of mankind. Propositions better established than that which asserts electricity to be non-producible from sufficiently economical sources have faded into oblivion. The energies of electricity are manifested whenever there is a molecular disturbance within or amongst bodies. Whenever any change takes place in anything whatever, and amongst any molecules whatever, an electric current is produced, and if not necessarily manifested to us, still it always is present. Probably there is not a single act of our lives, and it may be not even a thought in our heads, which is not associated with an electric current. Kindly understand that the lecture is on the energy of electricity, and, therefore, time must not be occupied in describing instruments. Galvanometers are now-a-days made so delicate that if you lay one finger in one trough of salt water, and another in another, and simply tighten the muscles of one arm, a current of electricity passes through the galvanometer and deflects the needle. We usually speak of a galvanic battery as being formed of zinc and copper, or of metals in chemically different relations to a liquid; if, however, you take a piece of ordinary copper bell wire, and connect the two ends of it to the galvanometer, then cut it in two with a pair of scissors, and dip each cut end into salt and water, or put them into your mouth, an electric current passes, and the galvanometer shows that there has been some species or other of molecular disturbance which has caused a manifestation of electrical energy. This energy of electricity becomes kinetic when it is allowed to pass freely. For example, in any bodies which are quiescent, it is kinetic, but it is potential when resisted. If, for instance, a current of electricity passes along a wire, and the action is resisted, the wire becomes hot. If it passes through any compound body, as, for instance, water, then it is resisted, and the water is immediately decomposed. Consequently we are dealing with an energy manifested in molecular disturbance, and having both a potential or stored-up power, and a kinetic power in motion. The question now is, how is this energy to be measured. Towards the middle of the last century (about 1746) the first electrical machine was made. In 1650, Otto Guericke, to whom we are indebted for the air-pump, suggested the scheme, but Hawksbee was the first to make one. His machine consisted of a ball of sulphur, afterwards altered to a ball of glass. The hands were employed to rub it, and a large fly-wheel, about six feet high, was employed to turn it. Silk threads from the ceiling held what we now call the conductor; and by the exercise of a very large amount of mechanical power they were enabled to get a small spark, to the surprise of all, to the curiosity of many, and the dread of not a few. After that we come to the plate machine, which is arranged, as you are aware, with cushions; still we have those sparks which were supposed to have much energy in them. We then pass on from the glass-plate machine to the vulcanite-plate machine. Sparks pass from the conductor, and are usually charged into a jar of this kind —a Leyden jar. That was first done in the year 1746. The mode in which electricity thus presenting itself was ultimately measured was by a small jar of this kind, called a unit jar. The state of the atmosphere and other surroundings so influenced the passing electricity that accurate comparisons and conclusions could not be made. Moreover, these jars vary on the surface, and in the character of the glass, and in other ways; consequently this mode of measuring energy must necessarily be a failure. The unit jar, therefore, has fallen into complete disuse. Let us now pass on to the mode of obtaining electricity from chemical action. Before doing so, a phenomenon should be noticed, which disturbs results very seriously, and which is, at present, not understood. Here is some copper wire, covered with cotton, coiled from end to end, say five or six times along this large bobbin of wood. Within the bobbin is a larger hole than usual. The two ends of this wire so coiled are connected with the reflecting galvanometer. The reflected light from this lamp is now visible and stationary upon the screen. You are aware that motion of that reflected speck of light will be the consequence of electricity passing through the coils of the galvanometer. Now observe that, without either chemical or physical agency acting upon or in contact with the wire, we shall obtain a manifestation of electrical disturbance within the copper wire. Let the end of this steel magnet be introduced within the bobbin, you see that the speck of light immediately moves. Except in this manner, copper does not manifest electrical properties. Again, if the other end of the steel magnet be brought within the bobbin, you see the speck of the galvanometer moves in an opposite direction. Thus may be shown one form of electrical induction. Now, with that phenomenon we are perplexed. This property of induction manifests itself at times and in ways of which we know nothing. For example, if a copper wire were laid upon this floor, and another copper wire were laid parallel to it on the floor below; and if any current of electricity passed through the wire on this floor, the one below would answer to it, although there was not any apparent contact or communication between them. The next stage in obtaining electricity is by means of what is called a galvanic cell. Such a cell usually consists of two different metals, and one or two liquids. Whatever may be the arrangement, the electricity developed may be estimated by the intensity of chemical affinity during the process, and at the time of the measurement. But the whole of this question of chemical affinity must now be assumed, and some of the affinities explained in the last lecture are probably the chemical affinities operating in this cell. A chemical action takes place upon a square inch of one plate, and it is met by an action upon a square inch of the other, therefore on every square inch an action is produced. Between the two plates there is something (say the liquid) which causes the action. It is in fact the presence of this liquid which calls the chemical affinities into play. A word must now be introduced which will often occur during the evening, and it is one which performs an important part in the measurement of electricity of the character which men utilise, *i.e.*, resistance. Indeed, this resistance to the free passage of an electric current is our chief business to-night. Whilst the size of the plates in these cells is increased, the resistance to the free course of the manifested electricity is not decreased. Thus, for instance, from a square inch of one plate there is a current of electricity meeting or co-operating with that developed from a square inch of the opposite plate. Whatever may be the energy of the chemical affinity upon one square inch, it is met by the energy of the chemical affinity upon the opposite square inch of the other, and that energy has to overcome the resistance of the liquid between them. Now, then, assume that each of these plates is enlarged by the addition of another square inch. This introduces an additional quantity of liquid, and we have to overcome the resistance of this liquid. It may perhaps make clear what is a difficulty to many minds if an attempt be made to explain how it is that an electrical current which passes when cells are coupled up "in series," that is, one after the other, is more intense than when they are combined as one large single cell. Supposing these two plates, each one square inch in area, were the only two concerned, therefore there would be a certain resistance to be overcome. The chemical affinity of one such combination not only overcomes that resistance but leaves a surplus of electricity, which surplus is said to run along the outside wire, and may produce what we call a telegraphic dispatch, Now, suppose that in addition to those two plates, there are two others of the same size and material in a cell behind them. Between these second plates there is also a resistance similar to that between the first two. Those two second plates, however, also produce a surplus. Now as that surplus passes over it continues its way through the previous plates and wire, and the consequence is that when once the resistance of its own cell has been overcome, the surplus electricity can pass through the other cells without any resistance, and, therefore, we are enabled to add the surplus of one cell to the surplus of the next, and so on. Electricity thus, or by other means at our disposal, is now to be measured. This electricity is measured in a very simple way. All the apparatus is here, but as it would take too long to show experiments in detail, perhaps you would kindly accept a statement of facts instead of a visible reproduction of them. In these cells is being produced a quantity of electricity which is to be measured, much as sugar is measured by the pound or liquids by the quart. The way it is measured is either by the chemical decompositions that it can produce, or by the amount of heat it can develope, or by other means, as for instance its effect upon the magnet in a given time. To consider a mode of measurement we must recur to those elements—mass, space, and time. The apparatus on which my hand now rests consists of a wooden ring, about ten inches in diameter, having coils of copper wire round it. Within this circular box with a glass top is a small magnetised steel needle. Now, the small steel needle assumes a certain position in consequence of the influence of terrestrial magnetism. Such an influence as this is not unlike a stream of water in a brook upon a short stick, one end of which is tied to a stake by a string. So long as the stream flows steadily past the stick it is retained in the same position. Let a disturbance take place in the evenly flowing water, and the stick will no longer retain either steadiness or direction. Suppose, now, that this needle is retained in a certain direction by the influence of what we may call the stream of terrestrial electricity flowing through the atmosphere of this room. (That such a stream is so flowing through the atmosphere shall be made apparent presently). From these four cells of a galvanic battery a current of electricity may be caused to pass along the wire which surrounds this wooden ring. The arrangements are made, and such a current is now passing. What is the consequence? The even flow of that which retained the needle is disturbed, and the needle answers as the stick in the water would have done to the disturbing causes. Clearly the nature and extent of the invisible disturbance may be estimated—indeed measured—by the motions of the visible needle, just as a new position assumed by the stick would measure the disturbing influence on the stream. The promise to let you have proof that there are currents of electricity passing through the atmosphere of this room may now be redeemed. Here is a circular wooden ring, with wire round it as before. You may notice that it can be turned as a looking-glass in its frame. The ends of the wire coiled round it are now connected with the wires of the galvanometer, the mirror of which reflects that speck of light on the screen. The looking-glass mounted ring is placed in reference to the (so-called) current of electricity always passing through the atmosphere, that were there a glass in the frame the current would beat upon that glass. If the frame be turned one-fourth round, then the current will pass parallel to the face of the frame. Or thus:—If the frame of the wire-enclosed ring be placed parallel to the direction of this magnetised needle, then the current of electricity through the atmosphere of this room is passing parallel to the ring. To move it, therefore, from this position to one at right angles to it, it is clear that the circumferential wire must, as it were, cut the stream of electricity, if there be one. Now, so cutting it, there will be a disturbance in the electrical condition of the wire, which may be manifested by a motion of that speck of light. Observe now, that every motion of the frame causes a motion in the needle of that galvanometer, which is placed on a stand far removed from the table on which the motion of the frame takes place. The two experiments now made may satisfy you:—1st. That there is what, for want of another name, we may call a current of electricity passing through the air; 2nd. That disturbance of the uniform quiet flow of this current may be caused; 3rd. That this needle is sensitive to such a disturbance; and, 4th. You will perhaps accept my word for that which time alone prevents being illustrated, viz., that the amount of this disturbance may be measured by the needle; that is to say, the greater the disturbance the further will the needle be moved from its original position. Telegraphy seems at present to have taken the most important position in the manifestation of the energy of electricity. Telegraphists therefore naturally consider how they can measure the energy with which they deal. The first question that presents itself is what may be called the measure of resistance. It was soon observed that electricity passed along certain metal wires more freely than other metal wires of the same size and length. The observation admitted of a very important utilisation. For example, suppose the wire now stretched from one end to the other of this room was one mile in length, and that the little apparatus with which electricity is being produced at this end could produce a certain result at the other end. Now, let us take another metallic wire of the same length, and suppose the result produced in this case is much less than in the first. It will be admitted, without any detailed experiment, that by shortening again and again, the second wire may be reduced to a length which permits the phenomenon at the end of the first wire to be repeated at the end of the second. Now measure the second; it is only one quarter of a mile. Try a third and a fourth wire; perhaps they are respectively reduced to one-eighth and one-tenth of a mile. Evidently there is some property in these wires which hinders, retains, or resists the progress of electricity. The property is called "resistance," and is available for very useful purposes. It may here be remarked that perhaps there have been no lectures ever given in this room of a more important and scientific character than a course of Cantor Lectures on electricity by Mr. Fleeming Jenkin. This course commenced in January, 1866, and will be found reported in the *Journal of the Society of Arts*, published between the 2nd February and 2nd March, 1866 (inclusive). In the experiments which determined what is called "the British Association unit of resistance," electric currents acted upon a very small needle carefully suspended, so that they were enabled to estimate the resistance of the wire in an absolute measure of space and time. That led to the adoption of what is called the "ohm," or "British Association's unit of electrical resistance." In this little glass cylinder there is a coiled length of German silver wire, German silver being used because it possesses great resistance to electrical currents, and that resistance does not change much with change of temperature. This coil constitutes what is called half a British Association unit, which becomes the measure of electrical work, just as the standard pound becomes the measure for weight, or the foot is the standard measure for length. Being possessed of this measure, we have all that is needful for the measurement of resistance, and therefore for measuring electrical work connected with telegraphy. To show the way in which a knowledge of this measurement can be utilised, rather than to enter upon those investigations by which it was obtained, seemed likely to win so much more attention and interest, that these arrangements before you are for this purpose. The intention is to show how electricians determine the distance at which a deep sea cable is broken, so that they can tell how far the fracture is from the shore. Let it be understood that it is the illustration of a principle, and not the nature and modes of dealing with different kinds of "faults," that are to be our concern. There is a wire, which may represent a cable, round the room. In this box there is placed a number of "ohms" arranged in three sets of nine each, so that by moving these pegs a current of electricity can be caused to pass through either one or more of them. Assuming each "ohm" in the first set to represent one resistance, each in the second set ten, and each in the third set one hundred, the consequence is that if a current of electricity passes through all, it would meet with a resistance of 999. If it passed through one of the first set, it would only be one resistance; so that with the moving of these brass pegs there is the power of bringing in any number of ohms required. This flat board, about 3ft. 6in. long, with a German silver wire and broad bands of copper divided at intervals, but capable of being put into electrical connection by the insertion of pieces of metal, constitutes what may be called the beam of electrical scales. Resistance, however, is to be measured instead of weight. Along a wire at the back electricity can pass, and when connected with the galvanometer the speck of that instrument serves the same purpose as the pointer of a pair of scales. If the galvanometer speck points to nothing, we assume that there is equilibrium between the resistances at each end of the scale beam. If I put 999 "ohms" in what we may call one scale, and other resistances into the other scale, or that which we may consider as such, then if the current of electricity arranged as provided can pass one of these groups of resistances more freely than the other, the speck of light will be moved. This is the same as though one end of a scale beam were "kicked up." Therefore resistances, which in this case act the part of weights on ordinary scales, must be taken out or added as may be required. This wire running partially round the room represents a cable. The two ends of this cable are in my hand. Let us assume that we want to measure the resistance the cable opposes to the energy of electricity, and to ascertain the value of its opposing power. Here is what is usually called a battery, consisting simply of a little salt and water, in a very small tumbler glass The wires from this battery are so arranged that th current may divide itself between the cable that i round the room and this box of "ohms." In the experiment before you the pegs in the box of ohms read 505; the speck of light is steady; therefore we know that the entire length of cable, of which the two ends are here, also offers a resistance of 505. Before this cable was laid, a comparison with these ohms had been instituted, and it was found (say) that one mile of the cable offered a resistance to the passage of electricity equal to one ohm, therefore there are 505 miles of cable, because there are 505 ohms. Now let us break the cable by cutting the wire. There! one end has fallen to the bottom of this large pan of salt and water. This pan must, for the present, be looked upon as an Atlantic Ocean, one end of the cable is at the bottom of it, and we wish to know how far from the end in my hand the separation has taken place. To compensate for the portion of the cable hitherto used, but now detached, the earth is available; this sheet of copper, in and on the shore of our Atlantic Ocean, is buried. Soldered to the copper is a wire, of which the end is in my hand. There are therefore in my hands the ends of two wires; one, that of the broken cable—the other, that connected with the buried sheet of copper. Let us deal with them as we did with the complete cable. [After various trials the pegs in the box of ohms were so arranged that the speck of the galvanometer was steady]. The speck is now steady, and the pegs read 350. This means that there are 350 miles of cable, or its equivalent. Now, the cable and the earth are the only elements on the one side; and since the earth is as a large reservoir of electricity it offers no appreciable resistance; hence the only resistance is that of the broken cable. The length of this is pointed out as 350 miles; this, therefore, is the distance of the fracture from the shore. How novel and delicate are the instruments employed, how accurate are the measurements obtained, and how marvellous are the uses to which electricity has been applied; yet these are not consequences of a blind rule-of-thumb following of that which has been long known. Patient research, persevering labour, and much thought have not only "put a girdle round the earth," but they promise fair to enter upon and possess electrical territories of vast extent and luxuriant social fertility. When will the people of England recognise this? Echo answers, "When!"

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* Abstract of the Fifth Cantor Lecture delivered before the Societ of Arts.

Students' Column.

Primary Electricity. By Robert Sabine, C.E.

Disturbances of the electrical equilibrium may be effected in a great variety of ways, the most striking being by means of friction. As a general rule, I believe it may be safely stated that, whenever the surfaces which are in contact of two heterogeneous bodies undergo any physical change, they have a tendency to take opposite electrical states. Thus a glass rod and a piece of flannel lying together appear to have no tendency to develope electricity between them; but the moment their surfaces are rubbed together the one becomes positively electrical and the other negatively so. A piece of antimony and a piece of bismuth lying together, under the same conditions of temperature, show no signs of electrical tension; but directly we change the temperature of their points of contact we set in action a thermo-element, and get a measurable tension. If the point of contact be heated, the electrical polarisation is in one direction; if it be cooled, it is in the opposite direction. There are of course bodies whose natures are such that they cannot come together at all without a change taking place, and therefore cannot come together at all without developing a mutual electrical tension. Thus it is with bodies which exert a chemical action upon one another, or have a natural tendency to absorb or combine with each other: for instance, a plate of zinc dipped into water strives at once to combine with one of the constituent parts of the water,—to become oxidised,—and the water and the zinc therefore assume at once opposite electrical states. And possibly all metals which are in oxygen, or even in atmospheric air, may be in the same condition, which would account for the electrical tension that Kohlrausch and others assert to have discovered by simple contact.

May not the explanation of these phenomena be that every body lying upon the earth's surface contains an amount of latent electricity according to its electrical capacity, just as every body lying upon the earth's surface contains an amount of latent heat according to its caloric capacity? We know that when we change the caloric capacity of a body we either liberate some of its latent heat, which becomes free and raises its temperature, or we cause the absorption of some of its free heat which becomes latent, and its temperature falls. Thus, gas upon being expanded cools; upon being compressed, becomes warmer. A glassful of water and a glassful of sulphuric acid, both having the same temperature when apart, are raised to a boiling heat when simply thrown together. In every case the caloric capacities are changed, and the surplus or deficiency of latent heat is given to or taken from the free heat of the body.

When the surfaces of two heterogeneous bodies, being in contact with each other, undergo a change, may not this change during its operation alter, in different degrees, their electrical capacities? The electrical capacity of the one being increased, it thirsts for more electricity than it possesses, and tries to take it from whatever direction it is to be had: the electrical capacity of the other being lessened, it is surfeited with what it has, and willingly gives its free electricity up to the other body. Or it may be that the action which takes place at the surfaces in contact tends to drive some of the electricity out of one body, and to accumulate it in the other. On separating the bodies at any moment, the cause of these changes—friction, heat, or chemical action—ceases, and the bodies become again free to resume their normal electrical capacities. In doing so, however, one of them finds itself deprived of that which, in the moment of its excitation, it freely parted with; whilst the other finds itself possessed of a superabundance. The one is negatively electrified, the other positively so. Thus, in an electrical machine, the instant during which the surface of the glass encounters the surface of the rubber, the electrical capacities of the touching surfaces may be modified, that of the glass being increased, and taking what it can get of the free electricity of the rubber, which it gives up again as soon as it passes beyond the influence of the latter, to the rake-collector of the prime conductor, because its normal capacity is then resumed, and its newly acquired electricity becomes free. If the rubber be insulated, its electricity is quickly pumped out, and the glass not being able to take up any more from it, the machine cannot produce anything. If the rubber be connected with the earth, the machine has an inexhaustible supply to pump from, and will go on pumping until it has heaped up a maximum in front of it. If the prime conductor and rubber are connected with each other, the electricity is pumped round and round in a continuous circuit.

To produce a maximum transfer of electricity in such a way between two bodies, it would follow that the change, whatever it may be, at their points of contact must depend upon the natures of the bodies operated upon. Thus, between glass and flannel we know that the production of electricity is best effected by rubbing these materials together; between antimony and bismuth, by warming or cooling the point of contact, and so on. But it by no means follows that, by warming the glass and flannel instead of rubbing them, and by rubbing the bismuth and antimony together instead of warming them, we should not produce also electrical transfers. We should not produce them to so observable an extent, but the difference would be one of degree only.

PAPERS FOR JUNIOR STUDENTS.

The Thomson Galvanometer.

In the last paper we sketched out the magnetic and electro-magnetic principles of the reflecting galvanometer, and in this paper it remains to consider another physical principle involved.

It is an optical law that the angle of reflection of a ray of light from a plane mirror is equal to the angle of incidence. Thus, a ray of light falling upon a mirror perpendicularly to the surface would be reflected back in the direction of the source of light. But a ray of light falling upon a mirror at an angle of 45° would be reflected at angle of 45°, the reflected ray and the incident ray making with each other an angle of 90°. This will be explained by the following engraving, Fig. 1, where L represents the light and M the mirror. When the mirror is placed at right angles to the ray of light from L, the ray is reflected again to L. But when M is turned through an angle of 45°, the ray of light, as shown by the dotted line of the engraving, is turned through twice that angle. Had the mirror been turned or deflected 20°, the ray of light would have moved through 40° of arc. Hence, if there were a scale of equal divisions parallel to the mirror, M, in its zero position, the spot of light reflected from M upon the scale would, by the position it assumed, indicate the strength of the current passing in the coils of the galvanometer. It is usual to consider these deflections of the spot of light from the zero or middle point of the scale as proportional to the strength of current passing in the coils of the galvanometer, but the supposition is not strictly true; for although it would be true for the tangents of the angles of deflection of the mirror itself, the spot of light describes, as we have seen, the tangent of twice the angle, and we have the following errors per cent:—

Deflection.	Error, per cent.	Deflection.	Error, per cent.
1	0·01	16	2·02
2	0·03	18	2·57
4	0·12	20	3·21
6	0·27	22	3·93
8	0·49	24	4·73
10	0·77	26	5·63
12	1·12	28	6·63
14	1·53	30	7·74

Thus, suppose that the relative strength of two currents successively passed through the galvanometer were required to be compared, and that the deflections were 4 and 14 divisions of the scale respectively, the error of the observation, if the uncorrected scale readings were taken, would be 1·41 per cent too great. The delicacy and other advantages of the instrument, and the smallness of the error, render the latter of little moment in practical work. For the laboratory, or for those tests where extreme accuracy is desired, the evaluation of the error becomes necessary.*

A few notes on the more advanced use of this instrument will be useful to those who can read ordinary formulæ.

To ascertain the value of one division of the scale in degrees of arc, we employ the formula—

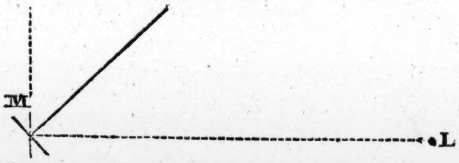
$$= \frac{28^{\circ}{\cdot}648}{d} = \frac{1718'{\cdot}9}{d}$$

where *d* is the distance (in the same measure as the scale divisions) of the mirror's surface from the scale. *d* is to be taken in millimetres, if the divisions of the scale are in millimetres. And to reduce scale readings generally to the corresponding arc, we employ (for deflections under 6°), the formula—

$$a = n - \tfrac{1}{3}\frac{n^3}{d^2},$$

where *n* is the number of scale divisions, and *d* the distance from mirror-surface in the same measure as the scale.

Fig. 1.



Should the corresponding tangent to the scale reading be required, we have the formula—

$$\tan a = n - \tfrac{1}{4}\frac{n^3}{d^2};$$

or the sine—

$$\sin. a = n - \tfrac{3}{8}\frac{n^3}{d^2},$$

these expressions being obtained from two terms of the development of a, $\tan a$, or $\sin. a$. For large deflections the angle may be calculated from the formula—

$$a = \tfrac{1}{2}\tan^{-1}\frac{n}{d}.$$

There are various measurements made with galvanometers, which partake of the character of instrumental coefficients, and are termed for each galvanometer its "constants." The term "constant" of a galvanometer, however, is, in practice, applied to one measurement only, and represents that deflection which would be obtained on the particular instrument, by including the galvanometer in circuit with one *megohm* of resistance, and one Daniell element.

The *figure of merit* of a galvanometer is the resistance that, with one Daniell element included in the circuit, will give a deflection of one degree in arc.

The methods of determining these constants and their use will be best obtained from the Reports of the British Association, and the advanced textbooks of electrical science.

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* We shall presently present to our senior students a paper or series of papers, on the Evaluation of Error in Electrical Measurements.

Correspondence.

THE MORSE CODE.

To the Editor of the Telegraphic Journal.

Sir,—In a previous number of the Telegraphic Journal (No. 12), a description was given of the device employed in the Government schools for readily committing the Morse alphabet to memory. It seems to me that a much simpler plan might be contrived, and possibly does already exist. But as I do not know of anything better, perhaps the following scheme, which I arranged for my own instruction, may be found useful. Let the vowels *a*, *e*, *i*, *o*, *u*, and also *s* and *h* signify the *dots;* the rest of the alphabet the *dashes*. Then the following words, which commence as far as possible with the letter they express, will give the Morse Code. The letters E and T, and the figures, from their simplicity, need no mnemonic.

A - —	at	N — -	no
B — - - -	base	O — — —	P Q R
C — - — -	cave	P - — — -	apps
D — - -	die	Q — — - —	Q Q E D
E -	e	R - — -	are
F - - — -	safe	S - - -	ass
G — — -	Gnu	T —	t
H - - - -	hush	U - - —	usk
I - -	is	V - - - —	asov
J - — — —	Ujgj	W - — —	awl
K — - —	Keg	X — - - —	vaux
L - — - -	ales	Y — - — —	yolk
M — —	my	Z — — - -	zwei

A few letters (such as J, O, and Q) present a little difficulty, which some of your readers may lessen, but as the scheme stands, the Code can be learnt by its aid in a surprisingly short time. It can of course be *written* at first easier than it can be read, but a little practice in writing soon enables it to be rapidly deciphered.

W. F. Barrett.

Notices of Books.

Handbook of the Telegraph. By R. Bond. Fourth Edition, revised and enlarged. To which is appended Questions on Magnetism, Electricity, and Practical Telegraphy, for the use of Students, by W. McGregor. Lockwood and Co. 1873.

This little work, one of the admirable series of handbooks published by Messrs. Lockwood, we are glad to see has been revised to the latest date as regards the description of instruments, codes, and rules. The appendix also will be found very useful. The whole work is to be commended to the student's notice.

Six Lectures on Light. Delivered in America in 1872-1873. By John Tyndall, LL.D., F.R.S., Professor of Natural Philosophy in the Royal Institution. London: Longmans and Co. 1873.

Dr. Tyndall's lectures, it is well known, gave great impetus to scientific culture in America. The subject selected, that of light, was one well calculated to attract, and, in his hands, to fix attention. The lectures were delivered successively in Boston, Philadelphia, Baltimore, Washington, and New York, becoming, as it were, "a kind of *growth*, which reached its most impressive development in New York and Brooklyn." Of the success of the lectures every mail brought word; the administration of the proceeds we have long since learnt from the papers. To detail the branches of the subject considered in the lectures would be impracticable; it will be sufficient to say that they combine an historical and experimental treatment, a method that Dr. Tyndall's readers know, under his pen, to be effective. The identity of light and radiant heat and their magnetisation are perhaps the questions most interesting to the electrician; but the other portions of the work are not of less interest. We do not remember a clearer explanation of the properties of pigments with regard to the colours they yield. "The rose," we are told, "is red in virtue, not of the light reflected from its surface, but of light which has entered its substance, which has been reflected from surfaces within, and which in returning *through* the substance has its green extinguished. A similar process in the case of hard green leaves extinguishes the red, and sends green light from the body of the leaves to the eye." Simple facts, as this, are rendered at the outset so clear to the reader that the understanding of more complex phenomena follows in due course.

In the appendix, we have Lord Brougham's articles on Dr. Young and the reply in the *Edinburgh Review;* a further description of the measurement of waves of light; on water crystallisation, being in part a contribution by Professor Henry, of the Smithsonian Institution; on life and crystallisation; and an account of Dr. Spottiswoode's researches on the spectra of polarised light. For a popular and so far thorough discussion of the subject as is suited to the lecture-table, the reader of whatever grade will find the work not only complete in a scientific sense, but more than usually entertaining. It will rank with the best of Dr. Tyndall's many admirable works.

Electrical Science in Foreign Journals.

Comptes Rendus Hebdomadaires des Séances de l'Academie des Sciences, Vol. lxxvii., No. 7.

Researches on Secondary Currents and their Applications.—By M. G. Planté.—In pursuing the study of the phenomena presented by secondary couples with plates of lead, I have made the following observations:—The chemical modification of the electrodes, which constitutes the source of the secondary current, is rendered more complete by alternate charge of the primary current in two directions, with repose between this double action. By the successive action of the primary current in two directions, the deposits of oxide are reduced, and the electrodes are modified in their molecular constitution not only at their surface but in their mass. By rest the deposits formed on the surface of the plates, whether the deposits be of metallic oxides or of reduced metal, acquire a crystalline texture and strong adherence which contribute to protect the sub-adjacent deposits tending to form themselves under the continued action of the primary current. By following this course of operation, which I have termed the *formation* of secondary couples, deposits of great thickness may be obtained, admitting in the discharge of calorific effects more or less prolonged. A secondary couple having less than half a square metre surface charged under the foregoing conditions by two Bunsen elements, will redden a platinum wire of 0·5 m.m. diameter during twenty minutes, and a wire of 0·2 m.m. diameter for about an hour, without any communication with the primary source, even forty-eight hours after charging. A battery of 1·5 square metre surface, equally well charged, preserved sufficient of its charge to redden a platinum wire for some minutes a month after charging. Although the *formation* of the secondary couples necessitates the use of two Bunsen couples, of which we change the direction, with intervals of repose, in order to give the deposits time to take a crystalline aggregation, once this operation is effected, it is no longer necessary to change the direction of the current, and the secondary couples can then be charged by the aid of a very feeble primary current acting constantly in the same direction, such as that furnished by a sulphate of copper element, even mounted with water around the zinc. The chemical work produced by this feeble pile accumulates slowly, but nearly without loss, in the secondary couples, and there will be received in the discharge effects of an intensity infinitely superior to that of the primary source. These observations facilitated the several applications of the secondary currents that I have already mentioned, and have led me to construct the apparatus that I have the honour to submit to the Academy. It consists of a small couple perfectly prepared, or *formed*, contained in a box, of which the base and sides carry a system of connections arranged so as to redden a platinum wire, and to ignite by simple pressure of a finger on a metallic touch, a wax candle, spirit-lamp, or gas-jet. The battery intended to put the apparatus in action consists of three elements of zinc and water, copper and sulphate of copper, and copper, and is placed at a distance or near the apparatus. It is not necessary to maintain the secondary couple constantly *en charge* under the action of the battery; for, once charged, we can produce a hundred consecutive ignitions. The ignition of a wax candle can be produced instantly, and such method of ignition is very economical and safe. The apparatus may be employed with electric bells in such a manner as to use only three cells of a sulphate of copper battery, being placed in a derived circuit from the primary and in direct communication with the two poles of the battery. It appears that, during the charge of a secondary couple under the action of a battery in whose circuit occur one or several bells, the couple absorbs all the current, and prevents the use of the bells; but, as the secondary couple acquires, under the influence of the battery, a high temporary intensity, it results that it does not act as an inert derived circuit, but itself contributes to the action of the bells. Further, if the battery is rendered too feeble to work the bells, the secondary couple is capable, by the electricity which it accumulates, of putting them in action. By a combination of the apparatus, not only may sound be produced, but light may be obtained at the same time.

Note Descriptive of the Cryptograph of M. Pelegrin.—Presented by M. Dupuy de Lôme.—This cryptograph is an instrument intended to convert into expressions which can be directly and secretly transmitted by telegraph the polar co-ordinates of points that determine a given figure. This cryptograph may serve to transmit sketches or designs by telegraph without resource to special transmittors. It consists of the graduated arc of a circle, with a cross-sight also graduated. The cross-sight carries a chariot, which traverses its length, as the cross-sight traverses that of the arc. For secret transmissions it is better that the divisions of the arc have nothing in common with known measures, but should be taken arbitrarily. The arc and the cross-sight are adjusted on a vertical plate, having an opening permitting a clear view of the ground upon which it is intended to work. This opening is fitted with glass, or some transparent diaphragm, upon which the design may be reduced. A sight placed at the extremity of a jointed arm, fixed on the edge of the plate, takes all the positions given by the sector determined by the arc and the two extreme positions of the cross-sight. This sight should not change its position during an operation. The chariot can be mounted at pleasure with styles of two kinds, replacing each other according to the work to be done, whether to receive or to design. The first style consists of a plate of very thin mica, on which there is marked a minute black point; the second, or reproducing style, consists of a fine steel point, which corresponds to the black point, and is maintained near the surface of the glass. All the positions assumed by these styles being given in graduations of the instruments, it is necessary only to telegraph these numbers to enable a distant correspondent to reproduce the design drawn by the successive positions of the points. The importance of such an instrument in military telegraphy cannot be over-rated.

No. 9.

Note on Siemens's Bobbin.—By M. A. Pellerin.—The Siemens bobbin has a great inconvenience that it gives rise, in the machines in which it is employed, to a considerable development of heat, and consequently a corresponding loss of work. It is possible that the origin of the greater part of this heat is in the induction currents development by the movement in the mass of metal forming the core of the bobbin. We avoid the production of these currents by forming the core of disks of *soft iron insulated.* The assemblage of these disks in a sufficiently solid mass is not an insurmountable difficulty.

Les Mondes. Vol. xxxi., No. 17.

Are the Stars Magnets?—By Dr. Prie (a correspondent).—In repeating Ampère's experiments on the rotation of magnets, we are struck by the extreme resemblance between the movements of magnets and those of the stars. On looking at the south pole, the current of the magnet is ascending to the right. Its two movements, translation and rotation on its axis, are descending on the same side. The earth is a magnet; it owes this property to the luminary heat that it receives from the sun. This cause existing for all, the other stars should also produce the same effects. The earth and the stars are an obstacle to the propagation of heat. This obstacle causes a current (Becquerel) in the direction of the shadow-cone, complementary to the magnetic current. The stars free in space, and subject to two permanent forces, have an accelerated movement rendered uniform by a resistance that equilibrates the force after a period of acceleration. Without resistance and under the influence of two forces, the star would attain after $\frac{1 \text{ revol.}}{4}$, a distance from the tangent and from its perpendicular passing through the centre of the orbit, equal to the diameter; it would acquire a velocity $v = g\,t$, or $v = 2\,\gamma\,t$, $g = 2\,\gamma$, and would describe a parabola. With a resistance which renders the movement uniform, it attains a distance equal to the radius; its velocity $v = \gamma\,t$, and it describes a circle. The resistance still produces rotation (Ampère), which diminishes the resistance. Looking from the southern pole, the earth and the stars, which have their magnetic currents ascending on the right, have their movements of translation and rotation absolutely in the same manner as revolving magnets. Nevertheless, before admitting the theory as a cause of astronomical movement, it is necessary, as with gravitation, that it justifies its admission by concordance with Kepler's law. By the first law, it should be alternately preponderating over gravitation and feebler by an equal quantity, so that it ought to be proportional to the distance from the sun, but in another proportion than gravitation. By the second law, it should have its origin in the sun. By the third law, proportional to the surface, it should diminish as the cube of the distance. These conditions are complied with.

Sul Principio di Volta.—By Signor Auguste Righi.—A very interesting memoir, by the Demonstrator of Physics in the University of Bologna, in which is discussed at length Volta's contact theory. The work describes original experiments, and photographs of new apparatus are given.

The Telegrapher. Vol. ix., No. 370.

Pope's Patent Repeating Electric Semaphore.—During the past few years the crowded condition of the main lines of traffic in this country has greatly increased the liability of the occurrence of collisions, and we accordingly find that the attention of inventors is now largely directed towards the improvement of signals and signalling apparatus. This has especially been the case in England, where, as a rule, the lines are crowded with a much heavier traffic than is usual in this country; and the necessity of a complete system of signalling is correspondingly greater. The ordinary semaphore signal, consisting of one or more arms pivoted to an upright post, which are capable of being moved into a horizontal position to indicate "danger," or a vertical position to indicate "safety," is very largely employed upon the English railroads. The apparatus is often worked at a considerable distance by means of a wire or cable attached to a hand lever at the signalman's box. It is obvious, however, that the distance through which the signal may be worked effectively in this manner is limited at most to a very few hundred yards, and even then much difficulty is often experienced in winter from the accumulation of snow and ice upon the cables and pulleys. Where the distance through which it is desired to operate a semaphore exceeds the above limit, an electric telegraph apparatus is employed in conjunction with it. The instruments are themselves constructed in the form of a miniature semaphore. One of them is placed in the signalman's box at the main semaphore, and another at the point from which the latter is to be controlled. The two instruments are connected in the usual manner by a telegraph wire, the distance, of course, being in this case immaterial. If, now, a "danger" signal, for example, is to be transmitted from A, and exhibited at B, in order to stop trains at the latter point, the signalman at A will first set the electric signal at B to "danger," at the same time notifying B by means of an electric bell. B then copies the movement of his instrument on the large semaphore, and then "repeats" the signal back to A by setting the electric signal at the latter point to "danger," whereby A is notified that the track is blocked by the semaphore at B. This arrangement is extensively used in England, with excellent results, but, we believe, has never been introduced, at least to any extent, in this country. It is evident that any means by which a signal could be exhibited at any required distance, without the aid of a signalman at that point, and its indications at the same time infallibly repeated back to the place from which the signal was originally transmitted, would be a long step in advance of the English system, both in safety and economy. The difficulty has been principally in the lack of any *absolute* means of registering the indications of the distant and consequently invisible semaphore. The invention we are about to describe is intended to overcome this difficulty in a very simple and ingenious manner, and has, we are informed, proved trustworthy and satisfactory in practical use. It is capable of being operated instantly at any distance, however great, transmits the return signal over the same wire that is used to convey the direct signal, and is said to be absolutely infallible in its indications—there being no possibility of error or mistake in the record of the position of the distant semaphore. Any person acquainted with the principle and construction of the ordinary Morse telegraph will have no difficulty in comprehending the apparatus from the following description:—The semaphore is placed on a post at the right hand side of the track, at a suitable height above the ground; the signal is exhibited through two openings, usually about twelve inches in diameter, covered with glass, and illuminated at night by a lamp fitted with a reflector at the back of the signal-box. The interior mechanism of the semaphore consists of a disk, about 30 inches in diameter, divided into four segments, alternately white and red. An adjustable counter-balance weight, attached to the periphery of the disk, keeps it in the proper position to show white, indicating safety, except when under the influence of the electric current; or it may be arranged to show red by the action of gravity, in which case a signal can only be shown when the machinery and battery are in perfect working order. The disk is made to turn through one-fourth of a revolution by means of an electro-magnet, the armature of which is attached to the short arm of an angular lever working on a fulcrum. The long arm of this lever is connected with a crank on the axis of the signal disk. Thus the disk will turn and show a red signal whenever the magnet is charged by the electric current. A supplementary magnet is provided for locking the signal in position when set red. The apparatus at the station may be at any required distance from the semaphore. It consists of a secondary or station signal—which, in principle and external appearance, is a miniature copy of the distant semaphore—a differential relay and a signal switch, for operating the semaphore. The battery for working the entire apparatus is also placed at the station. The operation of the apparatus is as follows:—If it is desired to set the distant semaphore *red*, the signal switch is turned on the danger stud, a circuit is thus formed from the main battery through the switch and magnet of the differential relay, semaphore magnet, and circuit changer. The relay magnet attracts its armature strongly, bringing the lever into contact with an arm, and then forcing the latter against a stop, so that the local circuit which operates the small signal is broken at one point, notwithstanding it was at the same instant closed at another. At the same time the magnet turns the semaphore disk. Just before the disk completes its movement, and after the red signal has been fully exhibited, a projection on the lever comes in contact with a corresponding projection on the circuit changer, and lifts it up, breaking the previously existing electrical contact which cuts the battery current off from the magnet, and instantly transfers it to the locking magnet. This occurs just as the soft iron armature on the periphery of the disk comes in contact with the locking magnet, and the latter, being now strongly magnetic, locks the signal disk firmly in its new position. The locking magnet is, however, wound with a much finer wire than the primary magnet, and the insertion of this great amount of extra resistance in the circuit weakens it to less than half its original strength in the relay. When this occurs, a spring which is adjusted with a strong tension, pulls the lever away from the relay magnet until it is itself arrested by the stop. At this juncture the local circuit is completed, and the station signal turns to white also, repeating the movement of the semaphore. In no possible event can the station signal change, *unless the distant semaphore has previously changed*. The accurate repetition of the distant signal is thus rendered *absolutely certain*.

Repertorium fur Experimental Physik. Vol. ix. No. 1.

On a Peculiar and Beautiful Electrical Phenomenon.—By Fr. Rossetti.—This is obtained in the following way: With the electrodes, *a* and *b*, of a Holtz machine are connected wires which proceed to two metallic rods, between the opposed points of which is a glass plate with a disc-shaped metallic coating on one side. The point of one rod presses against the glass; that of the other against the disc. It is, in fact, a modified condenser. Suppose the positive rheophore connected with the uncoated glass; then if the machine be put in motion, and *a* and *b* separated 4 or 5 m.m.; frequent sparks pass between the latter, and on the uncoated side of the plate a bright crooked line of violet hue appears encircling the point, and connected with it. On separating the electrodes further, the figure is more complicated, crooked branches reaching out from the centre-line, over the whole surface opposite the metallic coating. Reversing the rheophores (negative to glass, positive to coating), different figures appear—blue dendritic forms, branching out from the metallic point, reminding one of Lichtenberg's figures. With the electrodes widely apart, there are broad straight branches from the centre, dividing at the extremities into fine blue branches (these beautiful figures, as represented by the author, are worthy of examination). M. Rossetti points out that this mode of experiment may be made instructive in proving that water vapour is a good electrical conductor. If, when the sparks are frequent, and the figures small, one breathes on the uncoated surface, sparks and figures cease for a moment, but immediately begin again with increased intensity and brilliancy. The vapour at first acts like the metallic coating on the other side (thus completing an electrical condenser), until its condensation on the glass reaches a limit, when the discharges commence again. Indeed, the original figures are connected with hygroscopic action of the glass; a fine layer of vapour from the air permitting partial condensation of electricity. By operating in a damp atmosphere, one may obtain both kinds of figures at once on opposite sides of a thin sheet of glass without metallic coating (the Holtz machine being furnished with a condenser), but they are less distinct.

On Lamont's Magnetic Travelling Theodolite.—By Ph. Carl.

No. 3.

Mirror Galvanometer with Regulable Deadening (Dämpfung).—By V. Von Lang. (See p. 238 of this Journal.)

Gramme's Magneto-Electric Machine.—By Alfred N. Briguet.

Bifilar Electroscope for Lecture Experiments.—By W. Beetz.—This consists of a light shellac needle 15 centims. long, hung by two silk threads 50 centims. long, and 1 centim. apart, and carrying at one end a pith ball.

The Melograph at the Vienna Exhibition.—This is based on the idea of Caselli's Copying Telegraph. Each note, when pressed, closes a circuit, which produces a reddish mark on chemically prepared paper, moving by clockwork between the opposite poles. The marks are afterwards translated into the common notation. The pole points, in contact with the paper, are some of brass, some of steel, some of cobalt, giving different reactions and colours. The second and fifth octaves can be expressed by the first and fourth, a brown line being added. A metronome beats the time, marking the paper, and the performer is guided by it.

Scientific American, Vol. xxix., No. 7.

Lightning-Rods.—It was supposed by Charles and Gay-Lussac that a lightning-rod protected an area whose radius was double the height of the rod extending above the building, but this rule is no longer reliable, by reason of the extensive use of metals, in the shape of pipes, &c., in the construction of the buildings of our day. When electricity finds several paths to the ground, it will prefer the best, it is true; but some portion will also pass along the poorer conductors. If, therefore, any metallic substances lie within the area supposed to be protected, they are in danger of being struck. This is especially true where the lightning has a chance to jump to the gas- and water-pipes of a building. It is a good plan to connect these pipes with the lightning-rod; if the rod is struck, the electricity will then have an excellent path into the ground, and will be rapidly diffused over the vast under-ground network of pipes. The danger to the inmates of the house of being struck from these pipes is less than that of receiving a shock from the powerful induced currents, liable to be developed in them, if unconnected, during a thunder-storm. People are apt to be indifferent whether their houses and stores are provided with lightning-rods or not, and are always ready to give an example where some building so provided was struck in spite of its protection. Such cases have undoubtedly occurred, and they are often quoted by the old-fashioned "practical men" with much satisfaction, because they hail in them what they are pleased to call the victory of their sound common sense and the discomfiture of the scientific man. This class is, however, rapidly diminishing in numbers, under the influence of the extensive diffusion of scientific education among the people by popular lectures and by the press. It may be well to assure unbelievers that the efficacy of the lightning-rod is no longer an open question, and that any failures are attributable to bungling or ignorant construction. It would be an easy matter to multiply statistics in proof of the assertion; but none would carry with them more force than the following statement obtained from the records of the British navy:—Formerly the annual damage to ships by lightning involved an expense of £6000 to £10,000. Between 1810 and 1825 no less than 35 sail of the line and 35 frigates and smaller vessels were completely disabled; and in 200 cases recorded, 300 seamen were either killed or injured. When the lightning-rod was introduced, every mast was furnished with a capacious conductor permanently fixed and connected with bands of copper passing through the sides of the ship under the deck beams, and with large bolts leading through the keel and keelson, and including, by other connections, all the principal metallic masses employed in the construction of the hull (Harris). Since the adoption of this arrangement, "it appears that damage by lightning has positively vanished from the records of the navy." In one case, while the small frigate *Conway* was under refit in the harbour of Port Louis, the topgallant masts were down on the deck, and a small spar, not having a conductor, was substituted for the time to support the pennant. A thunder-storm came up, and the spar was shivered to atoms. No further damage was done, however, for the conductor on the topmast below the spar immediately carried of the terrific flash. No further examples are needed to prove that a lightning-rod, constructed according to the principles set forth, is a protector to life and property.

Journal of the Telegraph. Vol. vi., No. 16.

Suggestions Concerning the Care of Repeaters.—By Eugene Cadmus.—Experience has taught that the armature of the small coils of the relay needs adjustment but seldom if the locals are in proper order. The lever of the sounder is better adapted for sledge-hammer movement than that of the relay, and is rendered rather more effective thereby. Perhaps 3-16ths of an inch is not too much play, and here is the prime feature of the sounder, viz.: Let the tension on the lever be only moderate—a little more than enough to draw it up. It is utterly impossible to work well through a repeater, whereof the sounders are adjusted to sound as light as many operators prefer. When most efficient it usually sounds as if it dragged slightly. With their relay properly adjusted, they need not fear that the opposite side will be unable to break. Tight thumbscrews, clean points, and each pole of every magnet equidistant from its armature, conduce to the best results.

City and Commercial Notes.

The laying of a second cable from England to Denmark for the Great Northern Telegraph Company was completed on Sept. 2, 1873, by Mr. W. T. Henley, of North Woolwich. A cable also from France to Denmark, and one from Denmark to Sweden, have been laid by the same firm during the last few weeks, making an addition of nearly 1000 miles to the Great Northern Company's system.

The Eastern Telegraph Company's traffic receipts for the month of August, 1873, amounted to £28,091, and to £28,378 in the corresponding period of 1872.

The receipts of the Submarine Telegraph Company for the month of August, 1873, amount to £8220 13s. Those for the corresponding month of last year were £8477 3s. 1d.

The report of the Cuba Submarine Telegraph Company (Limited), shows an available total of £10,849, and a dividend has been declared at the rate of 5 per cent for the year, which will absorb £8000, and leave, after an appropriation of £2670 to reserve (thus raised to £8000), £179 to be carried forward. The traffic has fallen short of anticipations from the long-continued interruption of the Havannah to Key West cable, belonging to the International Ocean Telegraph Company, and from similar interruptions on the West India and Panama Company's system.

The Brazilian Submarine Telegraph Company (Limited) give notice of a call of £2 per share, payable on the 1st of October.

The total traffic receipts of the Great Northern Telegraph Company have been, during August, 1873, 294,541 francs; and in corresponding period of 1872 208,461 francs. On the European lines—In 1873, 157,616 francs; in 1872, 131,606 francs. On the China and Japan lines—In 1873, 136,925 francs; in 1872, 76,855 francs.

The *Hooper* steamer has successfully laid the cable of the Western and Brazilian Telegraph Company from Pernambuco to Para, where she was on the 23rd of August, waiting the arrival of the Great Northern steamer with the shore end on board. They telegraph to Pernambuco, "All well on board."

The *Liverpool Daily Post* understands from a correspondent just returned from Canada that it was reported there, in circles deeply interested in telegraphic enterprise, that the British Government, through Mr. Scudamore, are engaged in preliminary investigations tending towards the purchase of the Transatlantic Cables, which terminate in Newfoundland.

TELEGRAPH SHARE LIST.

Amount per Share.	Name of Company.	Amount paid up.	Closing Quotations.
£		£	Sep. 12.
Stock	Anglo-American (Limited)	100	89—90
10	Brazilian Submarine..	7	2¼—1¾ dis.
10	Cuba	All	8¾—9¼
10	Direct Spanish	9	½dis.—½pm
20	Direct United States Cable	11	7—5 dis.
10	Eastern (Limited)	All	8⅞—9⅛
10	Ditto New	All	8¾—9
10	Eastern Extn. Australia and China	All	8⅝—8⅞
10	Great Northern	All	9½—10
25	Indo-European	All	15—17
10	Mediterranean Extension (Limited)	All	5½—5¾
10	Do., 8 per cent Pref...	All	11—12
8	Reuters	All	10½—11½
Stock	Submarine	100	245—255
1	Do., Scrip	All	2⅜—2⅝
10	West India and Panama	All	6⅝—6⅞
10	Do., 10 per cent Pref.	7½	⅞—1⅛ pm.
20	Western and Brazilian (Limited) ..	18	7—5 dis.
1000 dls.	West Un. U.S. 7 per cent 1st M.B.	All	93—95
10	Hooper's Telegraph Works	All	12¾—13¾
50	India-Rubber and Gutta Percha ..	All	31—32
Cert.	Submarine Cables Trust	100	112—115
12	Telegraph Construction	All	33—33½
100	Ditto Ditto 7 per cent Bonds	100	102—105

The Eastern Extension, Australasia, and China Telegraph Company's traffic receipts for the month of August, 1873, amounted to £19,219.

At a meeting of the Western and Brazilian Telegraph Company (Limited) on Wednesday last, the Directors were authorised to pay quarterly dividends whenever they consider that the condition of the Company's affairs warrant such a declaration. The resolutions for a joint purse arrangement of this Company with the Central American Telegraph Company have been confirmed.

Patents.

3736. W. R. Lake, of London. *An Improved Insulating Compound for Telegraphic Purposes.* Dated December 9, 1872.—This invention relates to a composition of materials producing an insulating compound by means of which a more perfect insulation of telegraphic conductors is obtained than by the ordinary means; this compound is at the same time cheap and durable, and is not easily affected by the action of the weather. This compound is composed of one part coal-tar or its equivalent and two parts charcoal or sawdust, tan-bark, or any other organic body having a fibre and being a poor conductor of electricity, and which may be ground or cut up to mix with the tar. The coal-tar is brought to a boiling temperature when the charcoal is introduced and thoroughly combined with it by agitating the entire mass by any mechanical means. The proportions may be varied.

3809. S. W. Konn, of the firm of S. A. Kosloff and Company, of Great Winchester Street Buildings, London, and of St, Petersburg, Russia. *Improvements in the Means and Appliances for the Production and Maintaining of Light by Electricity.* Dated December 6, 1872.—This consists in producing the electric light by enclosing graphite conductors in hermetically closed glass cases filled with nitrogen or other non-combustible gas, so that when the current is led through the conductors they are not ignited, but only momentarily raised to a red heat. The current is led through a series of a considerable number of such conductors.

3839. J. Noad, of Middlesex, Engineer. *Improvements in and connected with the Manufacture of Electro-types.* Dated December 18, 1872. A new material is used for forming the moulds, consisting of lead melted and mixed with roll sulphur, ground fine, then mixed with gutta-purcha or its equivalent. To copy type this material is milled, brushed over with black lead, then softened and pressed on the type; afterwards it is put into a lead bath and worked by a battery, then washed and put in a copper bath and backed. To surface, the mould is put into a sulphate of copper bath containing 7 per cent free acid, the bath is worked with a large anode, and rubbed during deposition.

3880. R. S. Symington, of Glasgow, Telegraph Engineer. *Improvements in Applying Gas for Heating Purposes, and in Apparatus connected therewith.* Dated December 21, 1872. In one modification pieces of pumice-stone are arranged in the grate in imitation of ordinary lumps of coal, and the gas is admitted by one or more pipes, perforated with a number of small holes, into a space formed within or between the pumice-stone pieces. Air is admitted through perforated plates, at the back and bottom of the grate, or at the bottom only, to mix with the gas. Asbestos in a loose fibrous state is filled in between the pieces of pumice-stone, and the mixed air and gas permeating through this asbestos, burns amongst it, or on its surface, raising it and the adjacent pumice-stone to an incandescent and glowing state.

3936. G. M. Phelps, of Brooklyn, New York, U.S.A. *Improvements in Printing Telegraphs.* December 27,

1872. In the transmitting part of the instrument is a pulsator operated by clockwork, sending pulsations over the line. The pulsator is stopped, when a key is depressed. The receiving portion of the instrument has a type wheel moved by pallets, a lever and armature between two magnets. These magnets are in separate line wire circuits, or in one line wire circuit. In the latter case an automatic circuit changer is employed to alternate the connections to the magnets. The printing is effected by a local battery brought into action automatically, or by compound magnets, horse-shoe armature, and a reversal of polarity in the current, a screw and weighted lever unison is used. The pulsators are yielding, and the clockwork motor is regulated by a weight on a spring arm revolving within a stationary shell.

40. B. Hunt, of Middlesex. *Improvements in Printing Telegraph Instruments.* Dated January 3, 1873. The improvements consist mainly in a series of mechanical devices arranged and operating in combination with an electro-magnet and a polarized magnet under certain electrical conditions that each of the magnets shall release an escapement, the polarized magnet releasing the type wheel escapement and the electro-magnet that of the press mechanism; and further in the manner of actuating these escapements separately by two trains of wheels impelled by one main spring.

54. H. Kesterton, of Mosely, near Birmingham. *Improvements in the Construction of Metal Telegraph Posts.* Dated January 4, 1873.—A taper tube is rolled and cut into lengths, the ends are expanded into rings having lugs upon them, and I form clips or rivets are used to fix the parts together when the post is erected.

UNITED STATES.

139,690. H. D. Rogers, Cincinnati, Ohio. *Printing and Dial Telegraph and Circuit.* Dated May 24, 1873. Places Morse sounder and a printing or dial telegraph in same circuit and on same line. Printing circuit thrown on automatically when in use, cut out when instrument not in use. Combines Morse key and letter transmitter in one circuit breaker. The method of constructing the type wheel, by first forming the characters upon a flexible strip, which is then affixed to the type wheel frame.

139,692. J. Vansant, San Francisco, California. *Electrical Gas Lighting Apparatus.* Dated February 3, 1873. The gas valve at the burner is operated directly by an electro-magnet, whose helix is also employed in exciting a secondary induction coil for igniting the gas by a spark. A permanent magnet is employed with the electro-magnet, so as to obtain both attraction and repulsion; and to preserve the permanent magnet from deterioration it is surrounded by a coil whose direction of current is never reversed. The apparatus, including the gas burner, is insulated from the gas-pipe by an interposed tubular section of non-conducting material. By the use of a peculiar circuit breaker and switch the battery power is successively transferred to several series or districts of street lamps.

140,196. Abraham T. Hay, Burlington, Iowa. *Electrical Protection of Boilers.* Application filed February 14, 1873.—A coil connected with a galvanic battery is arranged around the steam drum or smoke stack of a boiler, in order to magnetise the said steam boiler, with a view to prevent the formation of incrustation therein. For the removal of crustation, scale, or solid deposit, the magnetisation of a boiler or other receptacle by means of a coil upon a core removed from contact with the fluid, applied in the manner and for the purposes substantially as described. In combination with the coil, the direct circuit through the boiler or other receptacle, as and for the purposes substantially as described.

140,591. Arthur Potter, Philadelphia, Pa. *Gas Lighting Apparatus.* Application filed December 12, 1872.—A small electro-magnet being arranged at each burner for controlling the electric spark, a rotating commutator provided with a rolling arm, and as many radial contact strips as there are burners, and each in circuit therewith, serves to light the burners separately in rapid succession.

140,618 Stephen Dudley Field, San Francisco, Cal. *Screw Post for Electrical Apparatus.* Application filed April 10, 1873.

140,737. Henry W. Spang, Reading, Pa. *Electric Railway Signal.* Application filed April 12, 1873. Circular signal frame divided into two or more signals, and attached at centre to shaft revolved by sector rack on end of armature lever. An electric railway signal which revolves on or around its centre, and the face of which is divided into two or more signals.

140,790. Frank L. Pope, Elizabeth, N. J. *Electric Railroad Signal Apparatus.* Application filed October 24, 1872. Secondary or tell-tale signal automatically set at the signaling station by the primary signal, both signal mechanisims being in the same circuit. Secondary signal, actuated by a "duplex magnet," circuit through one branch, going directly to battery or ground, and through other branch to primary signal; primary signal at conclusion of setting cuts a resistance in or out of its branch of circuit, destroying equilibrium of magnets at secondary station. The combination of primary signal and a secondary signal or indicator, included in or operated by one and the same electrical circuit, when the movements of the latter are dependent upon and controlled by the movements of the former.

140,340. Frank S. Baldwin, St. Louis, Mo. *Electrical Anemometer.* Application filed April 21, 1873.—Two wipers, connected with the wind-vane and insulated on opposite sides, are so arranged in connection with two insulated metallic circles, having projecting points, that when the vane moves in one direction metallic contact is made with only one set of points, and when in the opposite direction, with only the other set. These contact points being in circuit connection with electro-magnets, a swinging frame is caused to press against a clock revolving cylinder or fillet at each contact, and thus print a record of the direction of the wind at such times.

140,489. Thomas A. Edison, N. J. *Circuit for Printing Telegraph.* Application filed February 18, 1873. Two relays in main line circuit, central printing and type wheel circuits, form one local battery, the relays having polarised armatures and being so wound that one armature is attracted while the other is repelled. One or the other brought into action by reversal of current. Two polarised electro-magnets in a main circuit, in combination with two local circuit connections to the magnets of a printing instrument, and a mechanism for opening and closing the main circuit and reversing the polarity of the current.

140,536. Frank L. Pope, Elizabeth, N. J. *Circuit for Electric Railroad Signals.* Application filed May 15, 1873.—Combines with one battery several signal stations, each having its own signal, magnets, and circuit closers. Branch circuit from one station to station in rear reverses signal at rear station simultaneously with display of signal at forward station.

140,143.—Adolphus A. Knudson, Brooklyn, N. Y. *Printing Telegraph.*—Application filed May 15, 1873. The operation of printing throws in an extra pair of magnets, the spring of whose armature furnishes in drawing up the armature, the motive power to revolve the type wheel.

140,266. Miles W. Goodyear, New York. *Telegraph Sounder*. Application filed May 10, 1873.—Two electro-magnetic helices, the core of one of which forms the fulcrum for the armature lever, in combination with the armature studs and adjusting screws, which receive the blows of the armature lever.

140,255. Hiram Dodge, Beaver Dam, Wis. *Telegraph Pole*. Application filed May 24, 1873.—The cylindrical or conical metallic pole is slotted at the base and secured to a foot post by a ring; it carries collars near the top, having extended arms for supporting the wires in wooden plugs for holding the glass insulators, the rests being further insulated from the pole by rubber bands. The top of the pole is covered by a cap.

140,287. Emile Maertens, Philadelphia, Pa. *Electrical Stop Motion for Machinery*. Application filed November 27, 1872.—A spring lever held by a detent is so arranged as to cut off the steam power from machinery when released, and the said detent is tripped by the armature of an electro-magnet whenever its closed circuit is broken.

139,811. William A. Pitt, New York. *Lighting Gas by Electricity*. Application filed February 5, 1873.—A pivoted conducting wire, attached by an insulated support to a gas-burner, and in electrical connection with one pole of a battery (the burner being in connection with the other), is so connected, by a silk cord, with a swinging crank on the gas-cock, that, when the latter is turned to let the gas flow, the said pivoted wire is brought near enough to the gas jet to transmit a spark, and is immediately retracted by a spring.

139,819. Samuel Russell, jun. New York. *Electro-Medical Bath Tub*. Application filed March 17, 1873.—An inclined insulated diaphragm, provided with a central opening and a sliding gate, is arranged in the bath tub for the support of the back of the patient. A removable insulating foot rest is also arranged to be used, if desired.

139,953. John H. Guest, Brooklyn, N.Y. *Electrical Thermostat*. Application filed March 29, 1873.—Around the point at which the conducting wire enters the bulb of the thermomoter a glass chamber is formed, to be filled with soluble glass or other fluid, for preventing access of air in case the wire should become loose.

Rates of Pay for Communications by Telegraph, 1873-74.—The American Postmaster-General has issued the following Circular:—Whereas, by the Act of Congress approved July twenty-fourth, A.D. eighteen hundred and sixty-six, entitled "An Act to aid in the construction of telegraph lines, and to secure to the Government the use of the same for postal, military, and other purposes," in section second it is enacted—"That telegraphic communications between the several Departments of the Government of the United States, and their officers and agents shall, in their transmission over the lines of said companies, have priority over all other business and shall be sent at rates to be annually fixed by the Postmaster-General." Now, therefore, in pursuance and by virtue of the authority on me by said Act conferred, I, J. A. J. Creswell, Postmaster-General of the United States, do hereby fix the rates at which the telegraphic communication aforesaid shall be sent, for the year commencing on the first day of July, A.D. eighteen hundred and seventy-three, as follows, namely:—The rate for all telegraphic communications known as the signal-service messages and reports shall be three cents for each word of said reports and messages for each circuit over which it may pass in accordance with the schedule of circuits and plans of the Chief Signal Officer of the Army, which are now adopted, or may hereafter be adopted by him for transmitting these despatches, or such part thereof as he may designate, in such words or ciphers as may, from time to time, be directed by him. The amount thus estimated is to be taken in full payment for said despatches; no additional allowance to be made for drops, office messages, or other services or special facilities required by the Chief Signal Officer for the correct and prompt transmission of said signal-service messages and reports. The rate for all telegraphic communications, sent otherwise than over circuits established as aforesaid, shall be as follows, viz.: One cent per word for each circuit through which it shall be transmitted, said rate to be computed subject to the following conditions, viz:—A distance of two hundred and fifty miles, as computed by the tables of the Post-Office Department, shall be deemed a circuit. If, in computing circuits, there shall be found one or more circuits and a fraction of a circuit, such fraction shall be deemed a circuit. If a communication shall be sent a distance less than two hundred and fifty miles, that distance shall be deemed a circuit. All words of the communication transmitted are to be counted, excepting the date and place at which such communication is filed; all messages of less than twenty-five words, address and signature included, shall be rated as if containing twenty-five words, and all messages exceeding twenty-five words shall be rated by the exact number of words they contain, address and signature included.—Jno. A. J. Creswell, Postmaster-General.

The German Director of Telegraphs has decided to follow the example of the postal department and admit women into the service. The beginning is to be made with 200 clerkships, which are to be assigned to female candidates.

To Correspondents.

PRIZES TO STUDENTS.

It has been decided to offer, from time to time, to our Students, prizes for the best and most carefully considered paper on a given subject. By the kindness and courtesy of Mr. Robert Sabine, C.E., who has placed the funds at our disposal, we are enabled to commence the series with a

Prize of £25,

to be awarded to the Author of the best paper on "The Evidence of the Theory of Correlation of Physical Forces as applied to Electricity and Magnetism," received by the Editor of this Journal on or before January 1st, 1874. Each paper submitted for competition must describe original experiments. Each paper to bear (on every leaf) some word or motto by which it may be recognised. The same word or motto to be inscribed on a sealed envelope containing real name and address of competitor. The papers not selected will be destroyed with the envelopes unopened. Papers to be addressed to the Editor, and endorsed "Students' Prize." The best papers will be selected and submitted to a Committee of well-known Electrical Authorities (whose names will be published), who will award the prize for the most carefully prepared paper, irrespective of the view taken by its Author, whether favourable or unfavourable to the new theory. The award to be final. The Prize Paper to be printed in the columns of this Journal.

Errata.—"Mathematics for Non-Mathematicians." (Last paper).

Page 248, col. 2, line 26,

$$\text{For } B\frac{x}{y} = b\frac{x}{y} \text{ read } B\frac{y}{y} = b\frac{x}{y}.$$

Same page, col. 2, line 35,

$$\text{For } y = \frac{1}{\log.\ {}_bB} \text{ read } y = \frac{1}{\log.\ {}_bB}x.$$

F. E. S.—You do not show in your diagram where you connect the battery wires. If you attach them to the usual terminals your keys are all right. But why not use the simple reversing key? its use is much more frequent now than that of the system you describe. There are fewer contacts and less complication.

F. Koelbel.—The Editor will communicate with you if you will forward your address.

A. R. Granville.—Thanks for your corrections and suggestions. The errors are, you will see, typographical. We shall be glad to receive any further remarks. Would not the insertion of the formulæ you propose be now likely to confuse the beginner? It is the endeavour in these elementary chapters to avoid formulation as much as possible.

Our Report of Electrical Inventions at the London Internationa Exhibition is unavoidably postponed till our next issue.